ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0050

Online Teaching Practice of Applied Undergraduate Microcontroller Principle Experiment

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Abstract

The microcontroller principle experiment course adopts online teaching. In order to meet the teaching requirements of application-oriented undergraduate education, it draws on the experience of existing online courses and combines the requirements of Mount Taishan College's national first-class undergraduate course on microcontroller principle and application. The entire teaching process of online experiments has been rearranged. The online teaching platform has been reasonably selected, and online communication channels between teachers and students have been opened. A specially designed experimental development board has been created. The content of experimental projects has been carefully designed, and the implementation methods, evaluation, and assessment mechanisms of experimental teaching have been reasonably formulated. After a semester of online teaching practice, the students' assessment results are good, and their practical ability has been significantly improved.

Keywords

Applied undergraduate; Online teaching; Practical ability; Experimental teaching.

1. Introduction

The course on Microcontroller Principles and Applications is a core course for majors in electronic information, communication, automatic control, and instrumentation[1-2]. The Electronic Information Science and Technology major at Mount Taishan College is an applied undergraduate program. In order to enhance the practical abilities of applied undergraduate talents and strengthen practical teaching, the experiment of the Microcontroller Principles and Applications course is set up as a separate course with increased class hours, and a 32-hour Microcontroller Principles experiment course is set up.

2. Current Situation of Online Teaching of Microcontroller Principle Experiment

Traditional microcontroller experiments use classroom teaching methods, where the teacher explains the experimental principles, objectives, and steps, and students connect circuits, write programs, download and debug them on the experimental box[3-4]. Download the program to the experimental box, and students can observe the experimental results; By debugging the simulator program, the process of program execution can be analyzed. The teacher supervises the students' experimental process in class and promptly handles any problems that arise. During this process, students mastered the connection of circuits, programming, and debugging methods, and exercised their hands-on abilities. The experimental process was transferred online, and on-site operation using the experimental box was not possible. A combination of virtual simulation software Proteus and programming software Keil was used for the experimental method[5-6]. Students first use Proteus software to connect circuits, then write programs in Keil software environment, and then return to Proteus software environment for simulation. This process reduces the difficulty of experiments and requires a combination of

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offline and on-site experiments[7-9]. If this teaching method only retains the online teaching process, students will not be able to master the process of circuit connection, program download, and debugging, which is not conducive to the cultivation of students' hands-on practical ability.

3. Online Teaching Condition Guarantee for Microcontroller Principle Experiment

In order to complete online teaching tasks with high quality, the school encourages teachers to fully utilize network resources and laboratory conditions to reform and innovate online teaching. The school has successively opened online course platforms such as Smart Tree, Chaoxing Learning Platform, and Rain Classroom. Each teaching class has established dedicated QQ groups, WeChat groups, DingTalk groups, and other teacher-student communication channels for each course.

The online course platform has chosen Chaoxing Learning Platform to publish various materials for experimental courses, including experimental guidance, preview requirements, experimental project operation videos, experimental software, experimental report requirements, and experimental feedback. The teacher-student communication channel adopts DingTalk Group, which allows for text, voice, and video communication during online teaching.

Online experimental teaching, students are unable to use laboratory equipment such as the microcontroller principle and application experimental box and 51 microcontroller simulator. In order to ensure students' normal experimental operations, such as circuit connections, program downloads, simulation debugging, etc., the instructor has developed a "pocket style" microcontroller development board using the existing conditions in the laboratory, as shown in Figure 1. This microcontroller development board has a well-designed circuit structure and functional modules, which can complete the required experimental projects. It uses USB interface power supply and serial port cable to download programs. It is small in size and convenient for students to use. Experimental software, using Keil C as the development platform for program design; Use STC's 51 microcontroller software stc-isp-15xx-v6.85. exe to download the program.

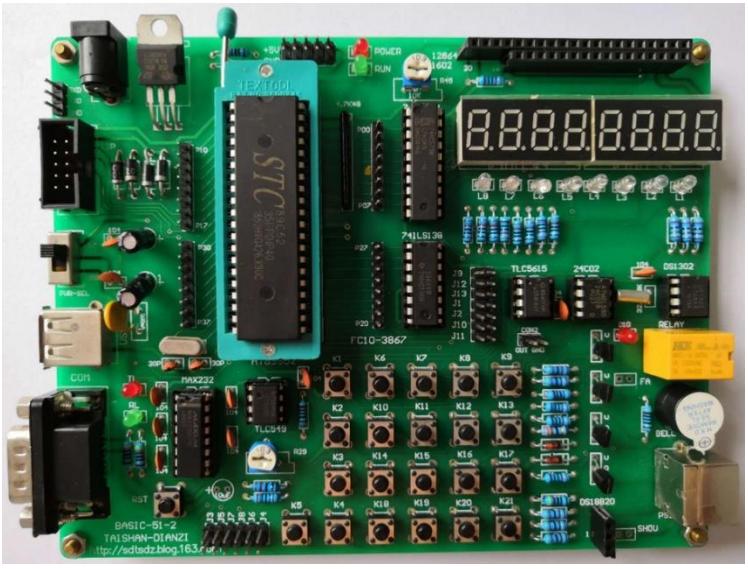

Figure 1. Pocket style microcontroller development board

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0050

4. Implementation Process of Online Teaching of Microcontroller Principle Experiment

4.1. Experimental Project Design

Experimental teaching is an extension of classroom theoretical teaching, which is the practice of theoretical knowledge. It requires introducing all the content of theoretical knowledge into experimental projects. At the same time, experimental projects must also meet students' learning and cognitive rules [10-11], from simple to complex, from basic to comprehensive. Online experimental teaching, students only have programming software, download software, "pocket style" microcontroller development boards, and serial download cables in their hands, and the available resources are much less than classroom teaching. According to the requirements of the Electronic Information Science and Technology major for microcontroller principle experiments, 10 experimental projects were carefully designed based on the actual situation of students' online experiments, including 6 basic experimental projects and 4 comprehensive experimental projects. The specific experimental content, requirements, and hours for these two types of projects are shown in Tables 1 and 2.

In addition to covering all theoretical knowledge, experimental projects also need to incorporate practical engineering needs. For example, the basic experimental project "6. LCD Screen Display" requires students to complete the LCD1602 screen display of two lines of static characters; According to the actual engineering needs, the display of free characters scrolling from left to right on the screen has been completed, which has improved students' awareness of engineering practice.

Table 1. Basic Experimental Projects

Number:	Experimental Project Name:	Experimental Content:	Experimental Requirements:	Experimental Hours:
1	Use of microcontroller development software	Keil C development software usage; Download and use the stc-isp-15xx-v6.85-exe software.	Master the operation essentials of Keil C development software program input, software settings, program compilation, and program simulation; Master the download settings and process of stc-isp-15xx-v6.85. exe program.	2
2	P1 port output	P1 port output controls 8 light-emitting diodes to turn on and off; Millisecond level delay program design	P1 port output controls the light emitting diode to turn on and off, with 8 light emitting diodes turning on in sequence and then turning off in sequence; Freely design the on/off sequence of 8 light-emitting diodes; The on/off time intervals for 8 light-emitting diodes can be set to 10ms, 100ms, 500ms, and 1000ms.	2
3	Interrupt control	External interrupt 1 triggered; Interrupt response program design.	Simulate interrupt generation by pressing the button, triggering external interrupt 1; Write interrupt response programs using edge triggered detection and level triggered detection respectively and compare them; Interrupt processing, control one LED to turn on and off.	2
4	Timer control	Timed for 1 second	Set timer T0 to achieve timing of 1s and 2s; Every 1 or 2 seconds, the LED will switch on and off, and use a mobile stopwatch to measure whether the timing is accurate.	2
5	Seven-segment display	The digital display shows numbers 0-9	Using dynamic scanning method, 8 digital tubes display any number between 0-9; Scan cycles of 8ms, 16ms, 32ms, 64ms, 128ms, and 1280ms, and observe the display effect for each scan cycle.	4
6	LCD display	LCD1602 displays characters	LCD1602 displays two lines of characters, I like MCU! And lcd1602; Display other freely playable characters and scroll the screen from left to right.	4

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Table 2. Comprehensive Experimental Project Status

Number:	Experimental Project Name:	Experimental Content:	Experimental Requirements:	Experimental Hours:
1	Key detection	Independent key detection and 44 matrix key detection	Using software debounce method to eliminate the front and back edge jitter of keys; Detect 4 independent buttons and display button values 1-4 on the digital display; Detect the 44 matrix buttons and display the button values on the digital display.	4
2	Serial port transmission	Serial port sends data, computer receives it	Set the serial port with a baud rate of 9600, 8 data bits, 1 stop bit, no checksum, and send a number to the computer every 0.5 seconds, ranging from 0 to 255; The computer displays received information through the serial assistant.	4
3	Serial AD conversion	Serial AD converter TLC549 detects external analog voltage and displays it	TLC549 detects the voltage at the middle tap of the potentiometer and displays the voltage value on the digital display. Adjust the tap position of the potentiometer to change the voltage value.	4
4	I2C BUS application	AT24C32 Data Storage and Reading	Write a program according to the I2C bus communication protocol, write data 0x12 to the unit with internal address 0x0000 in AT24C32, then read out the data from this unit and display it on the digital tube, and check if it matches the written value.	4

4.2. Teaching Scenario Design

4.2.1. Pre Class Experiment Preview

Using Chaoxing Learning Platform, you can publish experimental principles, requirements, and content PPT, as well as pre recorded experimental operation videos by the teacher. You can also publish experimental thinking questions, etc. Before class, students use the Chaoxing Learning Platform to preview experiments, understand the relevant situation of the experiments, complete experimental circuit analysis, program framework design, and thinking questions. For example, in the basic experimental project "5. Digital tube display" experiment, students analyze and think about the digital tube display circuit based on the "pocket style" development board; Design display program framework; Think about why the scanning cycle was set to 8ms, 16ms, 32ms, 64ms, 128ms, 1280ms in the experiment, and observe the display effect of each scanning cycle. Conducting the experiment with questions and your own answers can achieve better results.

4.2.2. Online Experimental Classroom Teaching

Online experimental classes, teachers use the Chaoxing Learning Platform to conduct attendance checks on students, and release recorded videos of experimental explanations, video tutorials on experimental operations, and safety precautions for experiments. Students write, compile, and simulate software programs on the Keil C platform, check for syntax and logic errors, and generate hex files; Using a "pocket style" microcontroller development board for circuit connection, download hex files to the development board through a serial port cable; Debug the program, analyze the results, identify issues, and achieve the expected experimental results. Teachers and students use DingTalk group video conferences for communication and interaction: on the one hand, teachers can video supervise each student's experimental operation and make experimental evaluations; On the other hand, if there are problems with student experiments, teachers can analyze the experiments through student experiment videos and guide students to solve the problems. For example, in the comprehensive experimental project "2. Serial Port Transmission" experiment, the student computer received data with a time interval of 0.5 seconds, but the data was incorrect and the student could not find the problem; Based on the experimental results and experience, the teacher can prompt students

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whether the computer serial port assistant settings are appropriate. The improvement of students' hands-on practical ability is effectively guaranteed in this process.

4.2.3. After Class Experiment Report and Tutoring

After class, students download the electronic version of the experiment report through Chaoxing Learning Platform, write the experiment report and take photos to upload. After the teacher reviews it, they provide feedback to the students. In addition, students have development boards and experimental software in their hands, which they can improve and expand their experimental projects on their own. If they encounter problems, they can seek advice from teachers in a timely manner through the DingTalk group. In this way, students who have extra energy and a strong interest in experimentation can receive more and better exercise and improvement.

4.3. Teaching Evaluation and Assessment

A good evaluation and assessment system for experimental teaching, evaluated and assessed from different perspectives [12], can truly and reasonably reflect students' mastery of experimental skills, and promote the improvement of students' practical abilities. The composition of experimental grades includes in class experimental project operation grades and out of class experimental report grades, with experimental project operation accounting for 70% and experimental report accounting for 30%. The experimental project operation and experimental report are both scored on a percentage scale, with each experimental project given a score and the average score taken at the end. The scoring rules for experimental project operations are shown in Table 3, and the scoring rules for experimental reports are shown in Table 4.

Table 3. Experimental Project Operation Scoring Table

Number:	Score Point:	Score:
1	Reasonable program structure and standardized writing	20
2	Proficient in using Keil C and downloading software	20
3	Safe use of electricity, non electrified operation	10
4	The wiring of the circuit board is correct	10
5	The debugging method is appropriate, and the downloaded program works normally	20
6	Observe the experimental results and analyze them reasonably	20

Table 4. Experimental Report Rating Table

Number:	Score Point:	Score:
1	Experimental Preview	20
2	The experimental report has a complete structure and detailed content	40
3	Serious and standardized writing	10
4	Analysis and Summary of Experimental Results	30

5. Conclusion

The microcontroller principle experiment adopts online teaching methods. In order to ensure the quality of teaching, the Chaoxing Learning Platform has been opened for online teaching, and DingTalk Group has been used for video communication between teachers and students; Specially developed a "pocket style" microcontroller development board for online experimental teaching. The teaching process was smoothly implemented, the evaluation and assessment methods were reasonable, the students' enthusiasm was high, and their hands-on practical abilities were strengthened.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0050

Acknowledgements

Suppored by the Tai'an Science and Technology Innovation Development Project (Project Number: 2024GX032).

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